What I claim is:

1. A method for acoustic, and in particular ultrasonic, receiver beamforming for use in ultrasonic imaging, said method comprising the steps of:

transmitting by means of at least one electroacoustic transducer at least one beam of acoustic wave signals into a body under examination, said signals being transmitted at a first frequency;

receiving said acoustic wave signals reflected by said body under examination through an array of receiving electroacoustic transducers;

synchronizing said signals received by each of said receiving transducers from one or more reflection sources arranged in a predetermined area, line or point of said body under examination by applying delays to said received signals by each of said receiving transducers, said delays being a function of acoustic wave propagation velocity and of the geometric distance of said transducers from said area, line or point of said body under examination;

summing said synchronized signals from said transducers;

separating from said received signals a component having a second frequency equal to an even harmonic of said first frequency;

transforming said separated components of said summed signals into image data of the structure of said body under examination;

displaying said image data by display means; and

wherein said delays are also determined as a function of the frequency of said received signals and as a function of the position of said receiving transducers in said array of receiving transducers.

2. A method as claimed in claim 1, characterized in that the delay calculation function depends, linearly or non linearly, on the position of each receiving transducer in the receiving transducer array.

3. A method as claimed in claim 1, characterized in that a term is added to the delay calculation function for one of said receiving transducers, said term being determined by said

second frequency, said term also being determined by the position of said one of said receiving transducers in said array of receiving transducers.

4. A method as claimed in claim 1, characterized in that said delay is a function of said component of said received signal to be used for image data transformation, and is such as to cause a phase shift of said received signals, such that components of said first frequency are suppressed when said synchronized signals are summed.

5. A method as claimed in claim 1, characterized in that said second frequency component of said received signals to be used for imaging is the second harmonic frequency of said first frequency.

6. A method as claimed in claim 1, characterized in that said delays are determined in a manner such that fundamental frequency components of said received signals are phase shifted by a half-cycle such that the harmonic components of the received signals of said receiving transducers are in phase, whereby said summing of said synchronized signals causes the suppression of components of said first frequency the harmonic components of said synchronized signals are summed in a non destructive manner to form an amplified signal.

7. A method as claimed in claim 1, characterized in that said delay for each of said receiving transducers is determined by using the following function

$$\frac{x_i \operatorname{sen} \theta_0}{c} + i \frac{1}{2 f_0}$$

where:

"i" = transducer index;

f0:= fundamental frequency;

X_i:= distance of the transducer "i" from a predetermined reference point;

θ_0:= steering angle.

8. A method as claimed in claim 6, characterized in that the signal resulting from the sum of receive signals is determined by using the following equation

$$b(t,\theta_0)=\sum_i s_i\left(t-\frac{x_i \operatorname{sen}\theta_0}{c}-i\frac{1}{2f_0}\right)$$

where: "i" = transducer index;

f_0:= fundamental frequency;

X_i:= distance of the transducer "i" from a predetermined reference point;

S_i:= receive signal from the transducer "i";

θ_0:= steering angle;

$b(t, \theta_0)$:= sum signal.

9. A method as claimed in claim 6, characterized in that in order to at least partly suppress or reduce the non-zero parts of said summed signal, a change in the phase shift direction of successive received signals is provided with reference to the moment in which said received signals are received from each of the receiving transducers of said transducer array, said phase shift being kept substantially constant for components at said first frequency and for said components at said second frequency.

10. A method as claimed in claim 8, characterized in that said function to calculate said delay for each of said receiving transducers is associated with a phase shift direction changing sequence in which the elements of said sequence are applied as a function of each of said transducers in said transducer array.

11. A method as claimed in claim 10, characterized in that said function provides a 0, 1, 0, 1, 0, 1, ... corresponding to a rem(i/2) function, where "i" is the index of each transducer in the transducer array, in lieu of the simple index "i".

12. A method as claimed in claim 11, characterized in that the function for calculating said receiver delay for each of said transducers is as follows:

$$\frac{x_i \operatorname{sen}\theta_0}{c}+\operatorname{rem}(i/2)\frac{1}{2f_0}$$

whereas the function for summing the receive signals from all receiving transducers is as follows:

$$b(t,\theta_0)=\sum_i s_i\left(t-\frac{x_i \operatorname{sen}\theta_0}{c}-\operatorname{rem}(i/2)\frac{1}{2f_0}\right)$$

where: "i" = transducer index;

f_0:= fundamental frequency;

X_i:= distance of the transducer "i" from a predetermined reference point;

S_i:= receive signal from the transducer "i";

θ_0:= steering angle;

b(t, θ_0):= sum signal.

13. A method as claimed in claim 10, characterized in that said function provides a sequence, 0, 1, 0, 1, 1, 1, ... corresponding to a (rem((i+1)/3)1) function, where "i" is the index of each transducer in the transducer array.

14. A method as claimed in claim 10, characterized in that said function provides a sequence including the elements 0, 1, 0, 1, 1, 1, ... and corresponding to a $(-1)^{(i+1)/2}$ rem(i/2), where "i" is the index of each transducer in the transducer array.

15. A method as claimed in claim 1, characterized in that said transmitting comprises at least one pulsed signal having an envelope with smoothed edges.

16. A method as claimed in claim 15, in which said pulsed signal comprises a triangular envelope.

17. A method as claimed in claim 15, in which said pulsed signal comprises a Gaussian envelope.

18. A method as claimed in claim 15, characterized in that said envelope is smoothed by using filters.

19. A method as claimed in claim 1, characterized in that said transmitted acoustic wave signals are generated within an envelope having smoothed edges.

20. A method as claimed in claim 19, characterized in that said signals comprise a triangular envelope.

21. A method as claimed in claim 19, characterized in that said signals comprise a Gaussian envelope.

22. A method as claimed in claim 1, characterized in that said delays are also calculated as a function of the distance of said reflection sources from the origin of a selected coordinate system which describes the ultrasonic beam propagation space.

23. A method as claimed in claim 1, characterized in that in the calculation of said delays includes a term relating to the value of said first frequency f_0 which is chosen to be greater than the effective value of said first frequency, said first frequency being the fundamental frequency of said transmitted beams.

24. A method according to claim 23, characterized in that the value of said term f_0 is increased by between 25% to 50% of the effective value of said fundamental frequency of said transmitted beams.

25. A method according to claims 23, characterized in that high-pass filtering of said summed signal is carried out with a cutting frequency lying between said fundamental frequency and said second frequency, said second frequency being the frequency of the second harmonic of said transmitted beams.

26. An ultrasonic imaging apparatus comprising:

at least one ultrasonic probe having a plurality of transmitting transducers for generating transmission beams, and a plurality of receiving transducers;

a beamformer coupled to said receiving transducers for applying receiver signal synchronization delays to each of said receiving transducers, said delays being determined with reference to the direction in which said transducers are focused;

means for processing received signals from each of said receiving transducers, including means for attenuating the fundamental frequency component of said received signals;

means for summing said received signals from their respective ones of said receiving transducers;

means for transforming said summed signals into image data;

display means for displaying said image data in the form of graphic images; and

a programmable control means for controlling said beamformer, said control means comprising one or more algorithms used for calculating said delays, said delays being calculated as a function of the position of said transducer in said transducer array, said delays further being calculated with respect to a predetermined reference point, based on the steering angle, on the focusing distance and on a predetermined harmonic of the fundamental frequency of said received signals.

27. An apparatus as claimed in claim 26, characterized in that said beamformer is programmed or controlled by said control means that is programmable to calculate said delays for each of said receiving transducer in order to generate a change in the phase of said received signals.

28. An apparatus as claimed in claim 27, characterized in that said phase change is caused by the functional dependence of delays from the selected harmonic frequency, particularly the second harmonic frequency of said received signals.

29. An apparatus as claimed in claim 26, characterized in that said beamformer is programmed or controlled by said control means in such a manner as to calculate received signals for each of said receiving transducer according to the following function:

$$\frac{x_i \operatorname{sen} \theta_0}{c} + i \frac{1}{2 f_0}$$

where: "i" = transducer index;

f_0:= fundamental frequency;

X_i:= distance of the transducer “i” from a predetermined reference point;

θ_0:= steering angle.

30. An apparatus as claimed in claim 26, characterized in that said beamformer is controlled by said control means in such a manner as to combine the phase shift of said received signals from each of said transducers, said phase shift being caused by the application of functional delays and by the dependence thereof from the selected harmonic frequency, particularly the second harmonic, with a phase shift direction changing sequence, composed of alternate "0" and "1" elements.

31. An apparatus as claimed in claim 30, characterized in that said phase shift changing sequence is defined by a rem (i/2) function, where "i" is the index of the transducer in the transducer array, the delay calculation algorithm being as follows:

$$\frac{x_i \operatorname{sen} \theta_0}{c} + \operatorname{rem}(i/2)\frac{1}{2 f_0}$$

where: "i" = transducer index;

f_0:= fundamental frequency;

X_i:= distance of the transducer “i” from a predetermined reference point;

θ_0:= steering angle.

32. An apparatus as claimed in claim 30, characterized in that said phase shift changing sequence is 0, 1, 1, 0, 1, 1, ... corresponding to a (rem((i+1)/3)1) function, where "i" is the index of each transducer in the transducer array.

33. An apparatus as claimed in claim 30, characterized in that said phase shift changing sequence includes the elements 0, 1, 0, 1, 0, 1, 0, 1, ... corresponding to a $(-1)^{(i+1)/2}$rem(i/2) function, where "i" is the index of each transducer in the transducer array.

34. An apparatus as claimed in claim 26, further comprising means for generating in at least one of said transmission beams a pulse comprising an envelope with smoothed edges.

35. An apparatus as claimed in claim 34, wherein said pulse comprises a triangular envelope.

36. An apparatus as claimed in claim 34, wherein said pulse comprises a Gaussian envelope.

37. An apparatus as claimed in claim 26, further comprising means for generating a smoothed envelope in the echoes contained in one or more or said received signals.

38. An apparatus as claimed in claim 37, wherein said echoes form a triangular envelope.

39. An apparatus as claimed in claim 37, wherein said echoes form a Gaussian envelope.

40. An apparatus as claimed in claim 26, further comprising means for increasing the value of the fundamental frequency f_0 in the delay calculation equations.

41. An apparatus according to claim 40, characterized in that the value of the term f_0 is increased to between 25% to 50% of the effective value of the fundamental frequency of said transmission beams.

42. An apparatus according to claim 26, characterized in said summing means comprises a high-pass filter having a cutting frequency lying between the fundamental frequency and the frequency of the second harmonic of said received signals.